On the Death of the Phillips Curve: Further Evidence

Richard Reichel

In a recent contribution to this journal, William Niskanen (2002) convincingly showed that the Phillips curve does not exist in the United States, at least not in the form usually proposed. Though there is a negative short-run relationship between unemployment and the inflation rate, the long-run correlation is positive. During the sample period 1960 through 2001, the nonaccelerating inflation rate of unemployment (NAIRU) is estimated at a low 3.7 percent, corresponding to zero inflation. These striking results provide a starting point for further research. In this article, I apply cointegration techniques to reproduce Niskanen's results and expand the analysis to other industrialized countries. The estimation results show that the concept of the Phillips curve should indeed be buried. As a policy guideline it is totally useless.

Niskanen's Model

Niskanen proposed the following functional form of the relationship between the unemployment rate U and the inflation rate I (t is the time index):

$$(1) \quad U_t = \mu + \gamma_1 U_{t-1} + \beta_0 I_t + \beta_1 I_{t-1} + \varepsilon_t.$$

This autoregressive distributed lag model (ARDL) relates current unemployment to the current inflation rate, the inflation rate lagged once, and the lagged unemployment rate. An ordinary least squares (OLS) estimation based on the period from 1960 through 2001 (annual U.S. data) yielded the following equation:

$$(2) \quad U_t = 1.487 + 0.594 U_{t-1} - 0.229 I_t + 0.464 I_{t-1}.$$

Cato Journal, Vol. 24, No. 3 (Fall 2004).

Richard Reichel is Associate Professor of Economics at the University of Erlangen-Nuernberg.

The estimated coefficients are highly significant, and the overall fit ($R^2 = 0.81$) is quite impressive. Surprisingly, the alleged Phillips curve is entirely short-run in nature. An increase in this year's inflation rate of 1 percentage point lowers overall unemployment by 0.23 percentage points in the short run. However, in the long run the negative effects of inflation dominate. Calculating the minimum sustainable unemployment rate by dividing the constant term by (1-0.594) gives a "natural" rate of 3.7 percent, corresponding to a zero inflation rate.

Thus, the major lesson of Niskanen's analysis is that there is no tradeoff between unemployment and inflation that could be exploited by policymakers. On the contrary, a stable price level will minimize unemployment in the long run.

Comments on Niskanen

Although Niskanen provides convincing evidence for the death of the Phillips curve, several comments are warranted:

1. It would be interesting to estimate his model for other countries in order to check whether the Phillips curve is still alive elsewhere. Theoretically, Niskanen's U.S. results could be an outlier.
2. Preliminary estimates of Niskanen's ARDL model for other countries gave somewhat puzzling results. For example, I obtained a "natural" rate of unemployment of 14.5 percent for Germany and 21.9 percent for the Netherlands, which seems unrealistically high. In most cases, the constant term of the equation on which the computation of the "natural" rate is based, is hardly significant. Thus, something may be wrong with the ARDL specification.
3. Methodologically, the estimation of an ARDL model by OLS is appropriate if the standard regression assumptions are not violated. Classical OLS is an efficient estimator when the variables included are stationary or integrated of order zero (I(0)). This implies that they do not exhibit trends or a changing variance over time (Greene 2003: 608). In our case, however, this is doubtful. The hypothesis of stationary data might be true in the U.S. case, but in several European countries one would expect I(1) series, as unemployment rates clearly show upward trends.

Nonstationarity implies that empirically estimated relationships could be spurious in the sense that they do not represent economically meaningful equilibria. For example, a regression of a random walk against another random walk could produce highly significant

coefficients and a good overall fit despite the fact that both variables are unrelated. This issue of spurious regressions has been addressed frequently in the literature and gave rise to the development of cointegration methods and the estimation of error correction models. As the Phillips curve may be vulnerable to spurious regression effects too, cointegration models should be applied in order to test for potential spurious effects.

Therefore, I will proceed as follows: First, I will analyze the properties of the unemployment and inflation time series. Second, I will show that Niskanen's ARDL model can be easily transformed into a simple error correction model. Finally, I will estimate the transformed model using time series data from 16 developed countries.[1]

Cointegration and Error Correction

Niskanen's ARDL version of the Phillips curve relationship can be easily converted into an error correction model (ECM) that simultaneously incorporates the long-term relationship between unemployment and inflation and the short-run adjustment dynamics.

Consider the ARDL model

$$(3) \quad U_t = \mu + \gamma_1 U_{t-1} + \beta_0 I_t + \beta_1 I_{t-1} + \varepsilon_t,$$

and define the first differences of the variables

$$\Delta U_t = U_t - U_{t-1},$$

$$\Delta I_t = I_t - I_{t-1}.$$

Solving for U_t and I_t, inserting into the ARDL equation, and rearranging we finally obtain

$$(4) \quad \Delta U_t = \mu + \beta_0 \Delta I_t + (\gamma_1 - 1)(U_{t-1} - \theta I_{t-1}) + \varepsilon_t,$$

where $\theta = -(\beta_0 + \beta_1)/(\gamma_1 - 1)$. An alternative version of this model, the well-known Koyck distributed lag $U_t = \mu + \gamma_1 U_{t-1} + \beta_0 I_t + \varepsilon_t$ yields the same error correction equation with $\theta = -\beta_0/(\gamma_1 - 1)$. The error correction form of the ARDL model has two components. The first describes the equilibrium relationship between the changes in the unemployment rate and the changes in the inflation rate. The second component is the equilibrium error $(\gamma_1 - 1)(U_{t-1} - \theta I_{t-1})$, which accounts for deviations from the equilibrium. A cointegrating relationship between U_t and I_t implies a negative sign of the coefficient of the equilibrium error $(\gamma_1 - 1)$, the so-called loading

[1]A comprehensive data set is presented by the European Commission (2002: 274).

coefficient. In this case, deviations from the equilibrium will be corrected and therefore indicate a stable equilibrium.

We can now distinguish several cases. If U_t and I_t are stationary, there is no need for an error correction model, and the ARDL model is appropriate. If the variables are nonstationary (I(1)), there are two alternatives. In the case of cointegration (i.e., a meaningful Phillips curve between U_t and I_t), we should obtain a significantly negative loading coefficient as well as a significantly positive θ. If there is no Phillips curve, the regression will not survive the differencing procedure. Thus, a "significant" level relationship in the ARDL formulation would be totally spurious.

Empirical Estimation

The analysis of the Phillips curve relation is conducted for 16 countries during the period from 1960 to 2001. We start with an examination of the statistical properties of the unemployment and inflation series and check whether the variables are stationary I(0) or difference-stationary (I(1)). This is usually done by unit root tests such as the (augmented) Dickey-Fuller (ADF) or the Phillips-Perron (PP) test. During the 1980s and 1990s, an impressive battery of tests was developed. These tests differ with respect to their null hypothesis, the handling of autocorrelation, the small sample properties, and many other aspects. In general, they suffer from relatively little power. For example, the null (series is I(1)) is too often rejected by the simple ADF test.

In our analysis, the following three tests are applied: (1) the widely used ADF test; (2) the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, which assumes stationarity; and (3) the Elliot-Rothenberg-Stock test (ERS). Without reporting detailed test statistics, the results for our 16 countries are summarized in Table 1.

The overwhelming majority of the tests indicate that the unemployment rate is I(1). The ADF results for Greece and Spain, however, show that the unemployment series are I(2), which means they have to be differenced twice to obtain stationarity. That result may be due to the sensitivity of the test to a sharp rise in unemployment rates during recent years. Additional unit root tests (PP, Ng-Perron) confirmed that the series are indeed I(1). With respect to the inflation rate, the results are more mixed. Whereas the ADF and the ERS tests indicate nonstationarity, the KPSS tests often reject this. Therefore, alternative tests were performed. All these tests indicate that the inflation series are I(1).

The United States seems to be a special case. It is not quite clear,

TABLE 1

Results of Unit Root Test on U and I

Country	U–ADF	U–KPSS	U–ERS	I–ADF	I–KPSS	I–ERS
Austria	I (1)	I (1)	I (1)	I (1)	I (1)	I (1)
Belgium	I (1)	I (1)	I (1)	I (1)	I (0)	I (1)
Denmark	I (1)	I (1)	I (1)	I (1)	I (1)	I (1)
Finland	I (1)	I (1)	I (1)	I (1)	I (0)	I (0)
France	I (1)	I (1)	I (1)	I (1)	I (0)	I (1)
Germany	I (1)	I (1)	I (1)	I (1)	I (1)	I (1)
Greece	I (2)	I (1)	I (1)	I (1)	I (0)	I (1)
Ireland	I (1)	I (0)	I (1)	I (1)	I (0)	I (1)
Italy	I (1)	I (1)	I (1)	I (1)	I (0)	I (1)
Japan	I (1)	I (1)	I (2)	I (1)	I (1)	I (1)
Netherlands	I (1)	I (0)	I (1)	I (1)	I (0)	I (1)
Portugal	I (1)	I (0)	I (1)	I (1)	I (0)	I (1)
Spain	I (2)	I (1)	I (1)	I (1)	I (0)	I (1)
Sweden	I (1)	I (1)	I (1)	I (1)	I (0)	I (1)
U.K.	I (1)	I (1)	I (1)	I (1)	I (0)	I (1)
U.S.	I (1)	I (0)	I (0)	I (1)	I (0)	I (1)

whether *U* is I(0) or I(1). This is due to fact that the U.S. series neither shows a significant long-term trend nor a changing volatility. However, considering the low power of the tests, I shall treat the U.S. unemployment series as I(1). Moreover this is motivated by the logic of cointegration. Regressing an I(0) series against an I(1) series would be inherent nonsense. A definite answer to the issue of integratedness must be given by the outcome of the ECM estimation.

For each country the ECM equation is estimated and the following sequence of results is presented in Table 2: Column 1 shows the simple correlation coefficient between the unemployment rate and the inflation rate; column 2 reports the short-run impact of inflation on unemployment—the coefficient β_0 of the ECM; column 3 presents the loading coefficient to show the presence of a cointegrating relationship; column 4 reports the long-run θ, which must have a positive sign if the traditional Phillips curve is a valid representation of the *U-I* relation; column 5 shows the overall fit of the error correction equation R^2; and column 6 presents the conclusions.

The results can be summed up:

1. There is not a single country where the traditional Phillips curve can be found as a long-run relationship.
2. The only long-run relation exists in the United States, but it clearly confirms the harmful effects of inflation as stated by Niskanen. It is beyond the scope of this article to analyze why those effects seem to be absent in other countries.
3. A significant short-run impact of inflation on unemployment could be identified in only 2 of the 16 cases—Italy and the United States. In all other cases, there are no indications of even a short-run positive impact of inflation on employment. Thus, in those 14 cases, it is not justified to call for monetary expansion even if policymakers are very short-run oriented.
4. In the overwhelming majority of cases, the traditional Phillips curve does not survive the differencing procedure and the cointegration test. Unemployment and inflation rates simply are not cointegrated. Any of the seemingly observed curves (9 countries) must be rejected as a spurious phenomenon. Moreover, this result does not depend on the sample period, as an estimation of the ECM based on alternative sample periods (e.g., 1960–1990, 1970–2001) revealed similar findings. Thus, trying to rescue the Phillips curve by arguing that the curve shifts over time (Ball and Mankiw 2002) is a tautology, and does not contribute to meaningful economic theory. Even if it were possible to identify economic factors that could consistently explain such

TABLE 2

ECM ESTIMATES OF THE PHILLIPS CURVE

Country	(1) Simple Correlation	(2) Short-Run PC β_0	(3) Loading Coefficient $(\gamma_1 - 1)$	(4) Long-Run θ	(5) R^2	(6) Conclusion: The PC is
Austria	**−0.78**	−0.11	−0.13	+0.04	0.15	spurious
Belgium	−0.27	−0.01	−0.02	−8.71	0.27	nonexisting
Denmark	**−0.31**	+0.19	−0.00	−33.60	0.23	spurious
Finland	**−0.53**	−0.08	−0.11	+0.73	0.08	spurious
France	**−0.44**	−0.03	−0.00	−17.07	0.23	spurious
Germany	**−0.66**	−0.08	+0.05	+3.86	0.27	spurious
Greece	−0.25	+0.01	+0.04	+0.99	0.20	nonexisting
Ireland	−0.19	**+0.10**	−0.00	−40.91	0.24	inverse in the short run
Italy	−0.29	**−0.08**	−0.04	−0.19	0.19	short run
Japan	**−0.70**	−0.02	**+0.14**	+0.12	0.29	spurious
Netherlands	**−0.48**	+0.16	+0.04	+4.04	0.22	spurious
Portugal	**+0.67**	+0.02	+0.00	+25.99	0.06	spuriously inverse
Spain	**−0.34**	−0.12	−0.01	−12.94	0.37	spurious
Sweden	**−0.61**	−0.14	−0.08	+0.31	0.12	spurious
U.K.	−0.18	−0.06	−0.05	−1.92	0.40	nonexisting
U.S.	**+0.36**	**−0.25**	**−0.58**	**−0.25**	0.55	short run

NOTE: Bold numbers indicate statistical significance at the 5 percent level in columns 1 to 4.

shifts (and thus noncointegration), the short-run tradeoff should always exist. But, as shown earlier, in the vast majority of cases this short-run relation is absent.

There is another opportunity to test the Phillips curve without running into estimation problems. Fortunately, there are data on the German unemployment and inflation rate from 1887 through 1914, a period characterized by fully flexible labor and goods markets.[2] In addition, during this period under the gold standard there were no significant market regulations. Unit root tests of the time series U_t and I_t clearly indicated that both variables are stationary so that the ARDL model can be estimated by OLS without transforming it into an error correction model. The results are striking. First, a scatterplot of the data does not show a simple Phillips curve relation. Though the correlation coefficient is –0.17, it is insignificant.

The ARDL results are as follows (t-statistics in parentheses):

$$(5) \quad U_t = 1.78 + 0.13U_{t-1} - 0.11I_t + 0.01I_{t-1}$$

$$(3.05)\ (0.51) \qquad (0.84)\ (0.08) \qquad R^2 = 0.06 \qquad DW = 1.57$$

Short- and long-run effects of inflation are visible as in Niskanen's equation, but the coefficients are not significant. The same applies to the lagged unemployment rate. Based on these results, there is a "natural" rate of unemployment of 1.78 percent, which is full employment.

Thus, Niskanen's funeral oration on the U.S. Phillips curve was certainly appropriate, but we should bury the other curves too.

References

Ball, L., and Mankiw, N. G. (2002) "The NAIRU in Theory and Practice." NBER Working Paper No. 8940.

European Commission (2002) *European Economy No. 6/2002.* Brussels.

Glismann, H. H.; Rodemer, H.; and Wolter, F. (1980) "Lange Wellen wirtschaftlichen Wachstums: Replik und Weiterführung." Kiel Discussion Papers No. 74.

Greene, W. H. (2003) *Econometric Analysis.* 5th ed. Upper Saddle River, N.J.: Prentice Hall.

Maddison, A.(1991) *Dynamic Forces in Capitalist Development: A Long-Run Comparative View*. New York: Oxford University Press.

Niskanen, W. A. (2002) "On the Death of the Phillips Curve." *Cato Journal* 22 (2): 193–98.

[2]Unemployment data were obtained from Glismann, Rodemer, and Wolter (1980: 35); the inflation rates were computed using Maddison's consumer price index (see Maddison 1991: 296).